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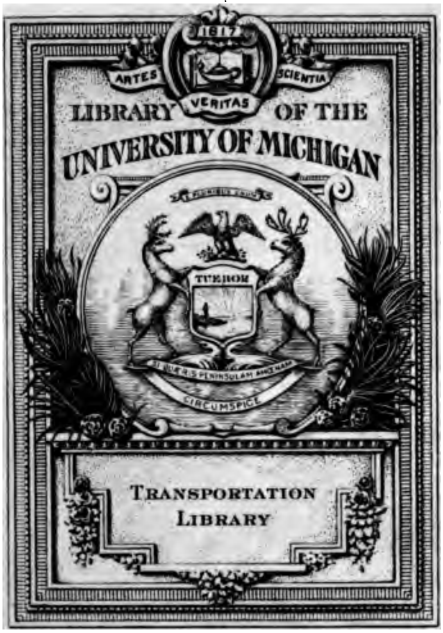

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DESCRIPTION

OF THE

SUSPENSION RAILWAY

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MAXWELL DICK.

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INTRODUCTORY REMARKS.

The effects produced by the increase of machinery throughout Britain, during the last thirty years, are not only apparent from the facility of intercourse which has taken place between different parts of the country, but are also acknowledged to be highly beneficial in a commercial, political, and literary point of view. We do not mean to say that, prior to that period, the progress of science had been slumbering for ages.—No; the history of our country furnishes evidence sufficient to convince us, that for several centuries bygone, Science, in its multifarious ramifications, was proceeding, by successive steps, from one improvement to another; and the greatest of these improvements—because the most advantageous and interesting—appeared in the Steam-engine. By it our commercial interests are much increased—the arts and the sciences receive a new impulse in their advancement—and the general state of society and of the country is greatly ameliorated.

Let these improvements go on—let every encouragement be given to the indefatigable mechanician, who wastes his days and nights in the pursuit of his favourite schemes—not so much from a spirit of self-interest, as from a desire to promote general good—and who can tell what may be the condition of things in half a century to come? "Science, like nature," as has been well observed, "is limited neither by time nor space, but belongs to the world, and is of no country and of no age. The more we know, the more we feel how much remains unknown."

Next to the Steam-engine in commercial utility, and as the greatest security in the transport of persons and property, are Railroads. Never was there a time when the attention of the public was more directed to any undertaking than it is at the present moment to these. Whether the individuals who are thus so enthusiastic in these undertakings are speculating for the honour of the nation, or with the prospect of a profitable return for their outlay, is what we cannot determine; but we should hope that the latter is not the *primum mobile*. The learned Dr. ARNOTT, in his *Elements of Physics*, viewing the national advantages likely to result from the introduction and progress of Railroads, speaks of them in terms at once philosophical and patriotic. Speaking of the increase of civilization as taking place very much in proportion to the facilities of intercourse enjoyed, he says, "The reason is obvious. When the situation thus binds a great number of individuals into one body, the useful thought or action of any talented individual, and which, were he in the insulated state, would soon be forgotten and lost, extends its influence immediately to the whole body, and becomes the thought or action of all who can benefit by it; it is recorded for ever, as part of the growing science or art of the community. And in a numerous society, such useful thoughts and acts are more frequent, because an emulation arises in all the pursuits that can contribute to the well-being of the society, from each individual feeling that he has the eyes of a multitude upon him, and that the rewards of excellence will be proportionally great. Men soon learn to estimate aright these and many other advantages of easy intercourse; and, after having seized with avidity all the stations naturally fitted for their purposes, they begin to make new stations themselves, and to improve upon the old; they create rivers, and shores, and plains of their own, that is, they construct canals, and basins, and roads; and thus connect regions which nature seemed to have separated for ever. In the British Isles, whose favoured children have so proudly taken the lead in showing the prodigies which wise policy may effect, the advantages arising from certain lines of canal and road first executed, soon led to numberless similar enterprizes; and, within half a century, the empire has been thus intersected in all directions: and it seems as if the noble work were now to be crowned by the substitution of level Railways for many of the common roads and canals. Several Railways of considerable extent have already been established, and although they and the carriages upon them are far from having the perfection which philosophy says they will admit, the results have been very satisfactory. If we suppose the progress to continue, and the price of transporting things and persons to be reduced by them to a fourth of the present charge, and in many cases it may be much less; and if we suppose the time of journeying with safety also reduced in considerable degree, of which there can be as little doubt, the general adoption of them would effect an extraordinary revolution and improvement in the state of society. Without in reality changing the distances of the places, it would, in effect, bring all nearer to each other, and would give to every part of the kingdom the conveniences of town and country, of seacoast and highland district. A man, wherever residing, might consider himself virtually near to any other part; for, at the expense of the time and money which he now pays to go a short distance, he might go a long one. The overcrowded and unhealthy parts of towns would scatter their inhabitants into the country; for the man of business would be as quickly and cheaply at his post from several miles off, as he is now from an adjoining street. The present heavy charges for bringing produce to market from great distances being nearly saved, the buyer every where would purchase cheaper, and the producer would be still better remunerated. In a word, such a change would arise as if the whole of Britain had been compressed by magic into a circle of a few miles in diameter, yet without any part losing aught of its magnitude or beauties. All this may appear visionary; but it is less so than it would have been, seventy years ago, to anticipate what has now come to pass, that the common time of travelling from London to Edinburgh would be forty-six hours."

With this learned author I do suppose that the progress of these improvements shall continue—that the price of transporting things and persons will be reduced to a fourth, or less, of the present charge—and that notwithstanding the present speed of our steam-boats, carriages, and post-coaches, the time of journeying will yet be considerably less. Who would suppose that, so late as the year 1784, letters were conveyed from the metropolis of England to distant parts of the kingdom by carts with a single horse to each, or by boys on horseback?

In making these remarks, the reader must not suppose that I consider my Suspension Railway to be the exclusive means of effecting such a mighty change in our affairs. However sanguine I may be regarding the advantages that may result from its adoption, yet I do not flatter myself that it is immediately to be put in requisition, and that by it I shall have the high honour of "seeing such a change arise as if the whole of Britain were compressed by magic into a circle of a few miles." By no means. What I have brought forward to-day as something new or excellent, may be followed to-morrow by something better: from one quarter we may hear of an invention fraught with the most beneficial results—from another, of a similar discovery, but greatly superior. So that much as has been discovered, much more may remain for future generations to bring to light. There may be hid in the bosom of nature and of science latent sources of facilities incomprehensible to the mind of man, and reserved for his pleasure, enjoyment, and advantage in a more perfect state.

But convinced as I am of the entire practicability, the safety, speed, and other advantages which will accrue from the adoption of the Suspension Railway which I now bring before the public, I am not so far misled as to imagine that it will be viewed in all its advantages at first sight. Well am I aware of the objections and prejudices I have to contend with, and that there will be much greater difficulty in giving the mind so tangible a hold of my invention at first, than there was with the Steam-engine when it was brought forward. In fact, the strongest objection (or rather prejudice) which I can perceive to be against it lies in this—that the mind is not prepared to comply with a scheme that so far exceeds its former calculations or expectations of speedy conveyance. Tell the people of our land thirty years ago, who never had heard of a steam-boat, that you saw a 200-ton vessel in the river, going without sails or oars, and against wind and tide, at the rate of ten miles an hour; would they believe you? I think not. Ask them, then, that if they choose to accompany you, they may see it—and, on seeing it, if they will "believe their own eyes." My opinion is, that even such a demonstration would be doubted by some. Let the reader say.

Such is a comparison of the difficulty of removing the prejudices against the scheme of conveyance which I now lay before the public. Until once the people see the plan operating on a large scale, they will not, generally, be persuaded of its practicability. All are convinced, that a small ship of three feet keel may be made as complete in all its parts, in hull, rigging, spars, &c., as a ship of 300 tons. In like manner I am convinced, that the models which I exhibit of a Suspension Railway, though small, do illustrate the safety, speed, and other advantages of my design, as faithfully as though it were erected on the most extensive scale desired. They have already confirmed many scientific gentlemen of the thorough adaptation of the general plan to all the purposes intended; with others, my illustrations had not the same effect. Familiarity with things already in practice is of no avail against the prejudices consequent upon things to be introduced.

Having made these few general observations, I shall state the circumstances that led me to the idea of a Suspension Railway; the experiments which I made before I got the same wholly to my mind;

and, without detaining the reader with any further remarks, proceed to describe how such a Railway should be erected.

In consequence of a very heavy fall of snow at the beginning of March 1827, much inconvenience was occasioned to the commercial and general interests of the country. For several days the roads throughout the country were completely blocked up, and travelling was wholly suspended. Experiencing, with others, the disadvantages thus occasioned, I thought of recommending to road-trustees the trial of a snow-plough, simple in construction, and trifling in expense. But the design of a Railway, on the principle of *Suspension*, occurred to me as the one most likely to overcome the whole difficulty: besides, it would afford a safety in rapid communication with light carriages practicable by no other means known to me. Being satisfied in my own mind of the success of the plan, I erected a temporary Railway in a private apartment, and made my first experiments with a carriage something similar to those I now exhibit. The result of these experiments seemed so favourable, that I determined to try them on a more extensive scale. Accordingly, in the summer of 1829, I erected a line of poles, extending about two miles, on a farm, near Irvine, belonging to his Grace the Duke of Portland. From the one end of this line I laid a rail of *rope*, about half-inch thick, upon which I placed the carriage; and taking the moving power to the other end, I set it in motion, and the velocity gained exceeded the rate of thirty miles an hour. This was over a rope rail of rough surface; the carriage was twelve pounds in weight, and the diameter of its wheels only two inches and a half.

In order to ascertain the power of drag required, I I attached a four-pound weight to a line passed over a whorle screwed on the top of a high pole at the one end, and the following was the result:—The first quarter of a mile required a force of four and a half pounds weight to raise the four pound weight to the top of the pole; the second quarter required a force of five pounds weight—increasing a half pound (or as near it as could be ascertained) in each quarter of a mile. This experiment was made with a spiral steelyard. The whole weight of line, extending two miles, was six pounds—the force required to drag over whorles the two miles of line, and to raise the four pound weight, was eight pounds, or two pounds less than the real weight dragged. This experiment was made with a very imperfect apparatus, or I am convinced the result would have been still more favourable.

I now proceed to give a brief description of the Suspension Railway, supposing it to be erected; with an estimate of the expense attending the same.

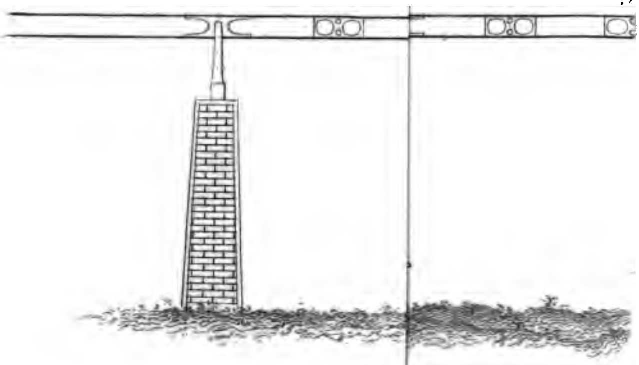
DESCRIPTION,

&c.

In the erecting of this Railway, the line of ground over which it is intended to pass, must first be divided into equal stages; the distances of these stages to be determined according to circumstances; especially the *purposes* for which the Railway is to be employed must be kept in view. We shall suppose, however, that stages of five miles apart may be laid down as a very probable criterion of the adaptation of this Railway to any part of Britain; and upon this supposition we shall proceed to explain. But it may first be necessary to state, for the information of those wholly unacquainted with the plan, that what I mean by stages, is the having of stationary engines placed equi-distant from each other; which engines are intended to be the working or moving power.

Whatever may be the surface of country, whether rising or falling, over which the Railway may be placed, matters not; even the crossing of rivers, mosses, marshes, &c. will be no barrier. And supposing it were wished, in carrying on the Railway, to keep clear of any house, or other object

Fig



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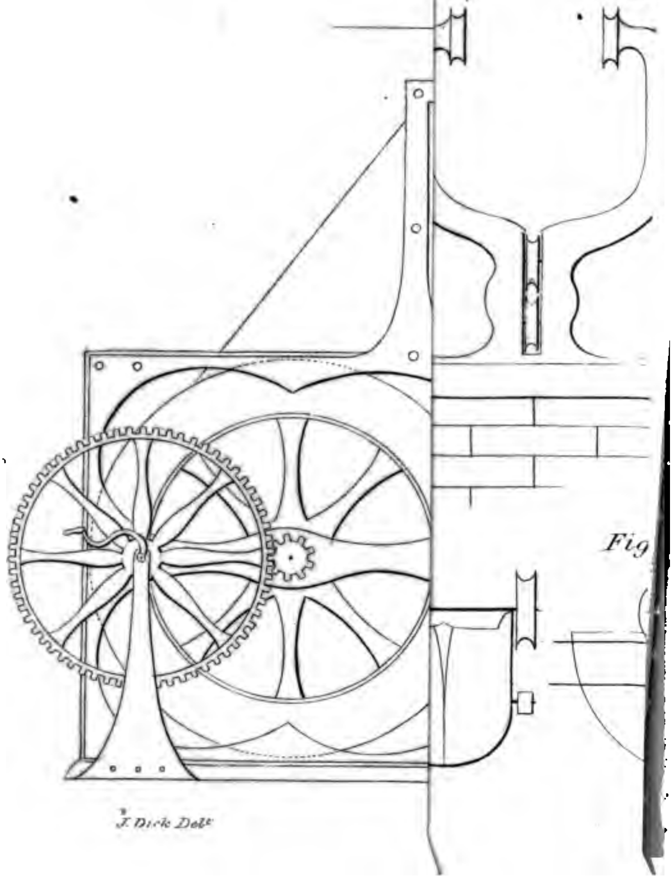

Fig

J. Dick Delt

UNIV. OF MICH.

that might intervene, this is also quite practicable, as the Railway is capable of being formed on an angle of several degrees, as shown in Plate I. Fig. 13. Although, at the same time, the straighter the line be the better, both in point of safety and velocity.

The line being surveyed, it will then be necessary to erect Pillars of stone and lime, at given distances, which must be regulated as experience may determine. In the meantime, however, we shall suppose the distance to be fifty yards. Between each of these there may be placed two or three cast-metal pillars, as occasion may require, for the purpose of adding strength, as well as for keeping the Rail completely free of any undulating effect. Each of these pillars bearing its own proportion of weight, as exhibited in the branch of suspension, Plate I. Fig. 16, and which pillars are intended to be of different heights and constructions, as circumstances or the particular situation of the country may require.

The pillars being all erected, the next thing necessary is to fasten a Frame on the top of each, for the purpose of securing the rails. These frames may be either of cast or wrought-iron; and are to be furnished at top or at bottom, (just as the line of pull may be, whether rising or falling,) with vertical, grooved friction-wheels: and into these wheels, from the particular shape of the frame, the drag-line (afterwards described) is always directed. Drawings of these frames, according to the kind of railway to be used, are shown in Plate I. Fig. 6, 7, 8, 9, and Plate II. Fig. 4, 5; from which it will be seen, that the railway may made a single or double railway; *i. e.* either with two rails or with four. Plate I. Fig. 8, 9, Plate II. Fig. 4, 5, are frames adapted for bearing and safety-rails.

The Rails I intend should be made of rod-iron, such as is used in the manufacture of chain-cables—of a diameter suited to the strength required, and in lengths as long as possible, as the fewer joinings the better. The joinings may be screwed, welded, or otherwise put together, so that the whole, from frame to frame, or from stage to stage, (whichever may be deemed most secure,) may form one uninterrupted length of rail. But lest the screwings or other joinings should weaken the rails, there may be added a strap of iron to the inner part of the rail, so as to make up the deficiency in point of strength. Each line of rail should be done in the same way; and the whole fastened down securely upon the frames, with pins, bolts, screws, or otherwise, the heads of which to be counter-sunk, or finished, so as to render the whole top-surface of the rail smooth, and free of all opposition to the wheels of the carriages. Between each frame there is also introduced, at every short distance, cast-iron Braces, in order to stiffen and entirely prevent any vibration or undulation of the rail. See Plates I. II., Fig. 1, 1.—Plate I. Fig. 2, 4, represent sections of railway, with bearing and safety-rails, and carriages thereon. Upon these safety-rails the safety-wheels of the carriage only act, in the event of the carriage receiving any sudden impulse upwards; and should such sudden impulse ever occur, the safety-rails and the under wheels coming in contact, the upward motion of the carriage is at once checked, and it proceeds forward with unabated speed.

The Carriages must be made of such a shape as will suit the arrangement of the rails—and be furnished with deeply-grooved bearing wheels. Those intended for the double, or safety-railway, to have four additional safety-wheels, with flat surface, to act on the under rails, for the purpose of preventing the carriage from starting upwards.

As has been stated above, the method proposed for dragging the carriage along the railway is, by fixed or stationary engines, acting with drag-lines or ropes attached to the carriage, which, if the railway be double, (as shown in Plate I. Fig. 9; and Plate II. Fig. 4, 5,) will act in an endless round; but if the line of railway be single, then the engine will be interchangeable and reciprocal. The one end of the drag-line is first coiled round the band-wheel of the engine—then passed down on the large barrel-wheel, which coils up the whole; and, on the return of the carriage, the barrel-wheel is ungeared from the engine. With a train of six half-ton carriages, a water-proof drag-line of half-inch in diameter, will be sufficient upon all stages, unless it be very hilly; then the strength of line, length of stage, and power of engine must be in proportion: and should the large barrel-wheel be nine feet in diameter, and four feet broad, 196 revolutions of this barrel-wheel will coil a mile of rope: in other words, the thickness of a five-mile coil upon such a barrel will not exceed 5 inches; but the strength of line and power of engine must depend entirely upon the level of the country, the weight to be drawn, and the velocity to be obtained. This method of drawing carriages is already well known; but I add, as an improvement to the engine at present in use, two teethed wheels and two pinions, by means of which a velocity with light carriages is gained, far exceeding any thing before gained by wheel-carriages. A plan or sketch of this engine is given in Plate II. Fig. 2, 3, exhibiting hand-cranks upon each axle, which, with light carriages, is intended to be wrought by manual power; but when heavy carriages are to be used, steam, horse, or other power may be applied. A double engine, placed in the middle of a stage of double railway, may keep two carriages in constant motion; and thus, by the alternately active and passive agency of two ropes or lines, the powers of fixed engines are made to act in opposite directions: thereby causing a road to be traversed both ways at once with great despatch. A water-fall, with a double reciprocating engine, in whatever part of the stage placed, may be taken advantage of, or the power may, on the level or slightly inclined stages, be wrought with the light carriages, simply by extending a stationary line, the tension of which would be self-acting by means of weights attached at both ends, and by passing this line once round a barrel-wheel fixed at the bow of the carriage—there might, by the addition of a teethed-wheel and pinion, with light carriages containing four or five passengers, a great velocity be gained; which carriage might be propelled either by the passengers themeslves, or by men for the purpose. By this means, one carriage might succeed another in as quick succession as they choose. With the patent friction-carriage upon a level stage, a power of three pounds would be sufficient to take forward a carriage of six cwt. at a great velocity; besides, having the power at their own command, they would be enabled to stop at pleasure. Powerful barrel-springs may also be employed to advantage as a moving power in particular situations. The railroad, however, is the principal object, the moving powers being many, from the spring to 100 horse-power-engines, if required.

DESCRIPTION OF THE ENGRAVINGS.

Plate I.

Fig. 1. A side section of one span of Suspension Railway with safety-rails and braces, the rails being supported by an inverted arch of iron rods or chains, by means of vertical rods. *(See Fig.* 11.*)*

2. Side view of friction carriage, with section of rails bearing and safety, and safety wheels.

Fig. 3. Front view of friction-carriage for railway, *Fig.* 16.
4. Side view of pivot-axle carriage, supported with strong plate-iron flanges, and having four acting and two spare wheels, in case of accident, placed upon section of bearing and safety-rail.
5. Front view of ditto.
6. Top-frame for single railway with vertical drag-line wheel at top.
7. Frame with broad sole for under-ground railway.
8. Top-frame for friction-wheel and common carriage.
9. Front view of top-frame for a double railway, upon the principle of *Fig.* 1, whereon the carriages go all one way, and return the other.
10. Side view of brace for railway, *Fig.* 1.
11. Front view of ditto, with vertical rods, furnished in the middle with right and left-handed screwed box, to raise and let down the rail as the weather may affect it in the contraction and expansion. The screws to increase in length as they reach the middle of suspension. *(See Fig.* 1.*)*
12. Vertical view of ditto.
13. Degrees of divergence which may be given to the railway from a straight line.
14, 15. Sketches of the line of railway, *Fig.* 1.
16. Sketch of railway for friction and common carriages.

Plate II.

Fig. 1. A span of suspension railway, supported between by three cast-metal pillars, with light top-frames, and with three stay-braces between each.
2. Drawing of a double, or reciprocating velocity-engine, which, by means of a double line, pass the carriages as far over it on the rail the one way as it brings it the other.

Fig. 3. Single velocity-engine, with double barrel-wheels, which are alternately ungeared, and, with a double line of rail, keeps up an endless passing of the line round both, whatever may be the length of railway; the two ends of which railway being furnished each with a horizontal band-wheel.

4. Front view of top-frame for a double railway upon the principle of *Fig.* 1.
5. Front view of the above, with grooved friction-wheel at top, used in ascending hills.
6. Common light carriage for ditto.
7. Stay, or brace-frame for ditto.

EXPENSE OF ERECTION.

The following is an abstract of the probable expense attending the erection of one mile of Suspension Railway, with a single line of Rails. Mason-work pillars, fifty yards apart, and with cast-metal pillars introduced at every ten yards:

Line of Ground whereon to build the Pillars—Breadth, Two Yards—extending One Mile—at £100 ⅌ Acre,	£72	10	6
36 Stone-and-Lime Pillars, 15 feet high—8 feet at base, 5 feet at top, 2 feet foundation, each containing 20 Yards Ruble Building—finished at Top with Freestone Cope; and including the Carriage of Materials—averaging the Distance at Two Miles—£6 4*s.* each,	223	4	0
Carried forward,	£295	14	6

Brought forward,	£295	14	6
32 Top-frames, with Friction-wheels, at £2 10*s.* each,	80	0	0
4 Ditto, used in ascending Inclined Planes, £3,	12	0	0
144 Cast-metal Pillars, 15 Feet long, 4 cwt. each, at 9*s.* ⅌ cwt.—£1 16*s.* each,	259	4	0
144 Light Top-frames for Do., at £1,	144	0	0
144 Land-stools, for Cast-metal Pillars, at 4*s.*	28	16	0
19 Tons of 7–8 Inch Cable-Iron, best Quality, at £12 ⅌ Ton,	228	0	0
648 Cast-metal Braces, at 1*s.*	32	8	0
3456 Sets of Keys and Pegs, at 2*d.*	28	16	0
3456 Holes and Rails, for Do. at 2*d.*	28	16	0
1316 Screwing-ends, at 1*s.*	65	16	0
Fitting up ⅌ Mile,	120	0	0
Total Expense for One Mile,	£1323	10	6

With the above it is unnecessary to include the expense of fixed engines, &c. as these should form a separate estimate, according to quality, number, situation, &c.

In my original estimate, the expense per mile was £1048 : 6 : 6, but I have been advised by several of our most eminent Engineers, in order to remove every doubt as to the entire stability of the erection, to introduce an extra number of Pillars, and other fastenings, which, no doubt, will all add to the strength; yet I am convinced of the sufficiency of the first estimate. After all, what a contrast does it offer to the expense of the ground railroad, the average expense of which costs about *Four Thousand, Five Hundred Pounds per Mile.*

It may be very naturally inquired, What the advantages are to be of the Suspension Railway over that of the Ground Rail? In explanation, it would be difficult for me to get at all; but I give the following as some of the most prominent. In the *first* place, as you save distance, so do you save time; which, all must admit that, in a commercial as well as in a political point of view, is of the utmost importance. The suspension rail takes a straight forward point from one town to another, without regard to the surface of country over which it has to go, whether rising or falling, crossing of rivers, or otherwise. All are, by regulating the heights of the pillars, with the same ease gone over; and, by that means, saving of distance, saving of surface ground, saving bends in the formation of the rail; which bends, besides the extra expense of originally laying, are always liable to great derangement from the lateral friction of the waggons coming round them, compared to that of a straight line of rail.

Secondly, The suspension railway over that of the ground railway has another immense advantage—that is, as far as expense is concerned; which is in the saving of all embankments, excavations, building of bridges, cutting of tunnels, besides the great breadth of surface ground.

Thirdly, And which I think the most important of all, is the great despatch to be gained by the suspension railway, without in the least degree endangering either persons or property, its height being sufficient at all places to allow every agricultural and commercial intercourse to go on under it without interruption; and then the carriages being so completely locked within the rail, prevent any chance of their escape, whatever may be their velocity: so that I do not stretch a point when I say, with light carriages containing the mail and all small packages, a velocity of sixty miles an hour is to be maintained, including all stoppages, and that with the greatest ease and safety. It has been remarked by some, could they not as easily go at this velocity upon the ground rail? It is evident they never can. Going beyond twelve miles an hour upon a ground railroad, and even at that the accidents would be innumerable, As example, I give the following extract from a pamphlet lately published, relative to the proposed railway and tunnel from St. Rollox, in the north quarter of the city of Glasgow, to the Broomielaw:—"Regarding the Kirkintilloch Railway, and Ballochney Railway Proprietors, they prohibit the passage of all persons along their roads, not only for preventing interruption to their trade, but on account of the great danger attendant on such passage. On the Monkland and Kirkintilloch, although in a course of nearly twelve miles it only intersects or crosses one turnpike road, a very great number of accidents, attended with the loss of life and limbs, have already occurred. In fact, it is impossible to prevent great danger on ground railways passing along crowded thoroughfares, and through thickly populated countries, even with the most careful drivers. The train of waggons, once set in motion, no human force can stop them in such time as to give safety to persons crossing the road."

Fourthly, The great opposition made by proprietors to the allowing ground railroads to pass through their properties, cutting up their estates and pleasure grounds, must be altogether avoided in the erection of suspension lines of rail. Properties will, with them, be as much enclosed and secure as before. Indeed, the columns and other erections passing through may be made more an ornament than otherwise. Besides, straggling persons would have no right on the ground below, except the bearer of a mandate from the Railway Company, for some repair or other business. Thus an evil of the greatest magnitude is got rid of, besides the waggon-drivers, who are, generally, a set of the most regardless and lawless characters that exist.

Between Glasgow and Edinburgh such a mode of conveyance is highly adapted. Instead of one or two mails a-day, there might be six or eight between these cities. By the present mode, a letter takes five hours to travel;—by the mode I recommend, one hour would not be taken up. The present mode (referring to the intercourse between these cities) keeps the merchant and the man of business a whole day in suspense. The mode I recommend would set all this aside. In the language of the Memorial of all the Public Bodies in Edinburgh unto the Lords of His Majesty's Treasury, regarding the Acceleration of their London Mail, I may say—but with the greatest deference for using their words—that, "in adopting this great and important improvement, there may in the meantime be a great expenditure, but this must be very unimportant; and, judging from past experience, would be much more than compensated, by the increase of revenue arising from the increase of facility in the interchange of correspondence. * * * * * Besides, when a constitutional view of the post-office establishment is taken, it appears, that while, from the surplus remaining, after defraying the expense of conveyance, a source of revenue is on the one hand afforded to the Crown—Parliament has provided that the utmost 'speed, expedition, and safety,' on the other hand, shall be secured, and guaranteed to the subject."

By adopting the mode I recommend for the conveyance of the mail, the velocity might be fifty or sixty miles an hour. Its safety guarantees me to state a much greater velocity; but it is optional to increase or diminish it, as found necessary. The carriages may be constructed for the accommodation of passengers; but the degree of velocity applicable to the conveyance of the mail might be too great for them. Perhaps half the speed would be sufficient, at least for some time, or until its stability was found unquestionable and its safety fully established. The passengers being all inside of the coach, they will not feel the least incovenience, although going at double the velocity. But the purposes to which my invention is applicable are numerous, there being no necessity, as there is upon the ground rail, of making the rail, and all its apparatus, about six times the strength that would be necessary, did they use any other power than locomotive steam-carriages. Not only have they to make the rail sufficiently strong to bear the ponderous weight of the locomotive carriage, but they have to make it to stand all its working effect, as in it is concentrated the whole stress of drag, which, necessarily, must be very great in order to bring forty or fifty tons of weight behind it; and indeed they profess to do a great deal more. Such a rail must be very substantially laid, or the wear and tear will, no doubt, be very great. The stationary engine or horse acts otherwise: by either of these powers, with a light rail, a great deal of work can be done. There being no economical purpose served by having waggons to contain two or three tons weight; but by having the waggons of half a ton, a greater number may be taken in the train; and, by this means, with a light rail you will, with light carriages, have the same quantity of work done in the end, and a great saving is to be made besides the annual repairs, which, I am convinced, would not be a tenth of the expense of that of the ground railroad.

To put the thing in operation to answer any purpose, it is only necessary to have it erected substantially; while the whole expense of erection, even on a scale sufficient for the heaviest goods, would not cost above one-half of the expense of a common railroad. The rails, notwithstanding what I have said of their thickness, may be of any dimension. The greatest distance they will be from the point of suspension is five yards, and it is well known that an iron rod of one inch diameter, and at this distance from the two points of suspension, is capable of sustaining 16 tons; and if two inches diameter, it will, from the same points, support 80 tons. But the greater the velocity of the carriages the less will be the weight on the rails; and as no irregularity in this takes place, except in the *accelerated* motion, when the moving power is first applied; and in the *alternate* motion, when the moving power is retarded, at both these places there may be an additional support to the suspension, if preferable to a stronger portion of the rails.

Among the number of gentlemen who witnessed the models of my carriages and railway during their exhibition in Glasgow, it was not to be expected that they should all be unanimous on viewing their practicability on a large scale through the same favourable medium as I do; or that they would approximate to harmony of sentiment, by being all either *pro* or *con.* It were foolish to expect such a thing. Some said the design was not only a good one of itself, but as safe and expeditious as though it had been tried and practised for years—others maintained that it was not adapted for general conveyance; and while some objected on the ground, as they said, of its liability to be robbed, others had no apprehension of that, were such or such another thing obviated. Thus a variety of opinions, hostile even to one another, were brought to bear on my invention. It has been, and will be so with every innovation: and why not? Every man has a right not only to think and speak freely, but even to make known his sentiments to the world; and, instead of shrinking at an inquiry into my invention, I the rather court it; as it gives me an opportunity of answering, if I am able, such objections as may be thrown against it, or of obviating any defects that may be pointed out. In regard to the objections against it, I shall glance at the most formidable, because the most general; others which were stated I conceive of so frivolous and captious a nature as not to require a reply.

The carriage is so completely secured within the double rail, that there is no possibility of its abstraction—indeed, nothing short of breaking down the railway could effect it; and this could not be accomplished without detection, for the very moment that any obstruction takes place, an alarm will be given at both engines, by means of a connexion of teeth-and-pinion work, which will exhibit, upon a dial at both engines, the progress of the carriage along the whole stage; so that, if any accident should occur, the exact place is at once known by reference to the dial; which dial also exhibits all the inclined planes down which the carriage may run. When a drag-lever is applied to the barrel-wheel, which has the complete effect of checking its too sudden progress, the carriage is also brought up at the end of the stage in the same way.

The security thus given to the carriage, while it overthrows the objection of its liability to fly off the rails, applies also to the impossibility of effecting its robbery. We have supposed all along that the carriage, however light, may convey a guard along with it, who may be in possession of fire-arms, and so prevent any mischief being done in this respect. But let us now suppose that no such person attends—that the carriage proceeds alone, and that, too, through a solitary and unfrequented district of country, where nothing apparently could hinder the thief from making an attack. Even in such circumstances it is safe; because the carriage is secured by means of the four *locking* rails; and when an obstruction to its progress takes place, the alarm is so instantaneously given by means of the dial, at both engines; which, supposing an attack to have been made at the middle of a five-mile stage, is only two miles and a half from either of the engines. But, by using the double engine in the middle of a five-mile stage, the greatest distance from the attendants at which an attack could be made is one mile and a quarter. Therefore, how could it be possible that four bars of iron of 7–8ths of an inch in diameter could be broken, or that the carriage, so firmly locked in, could be dismounted, or its strong locks and bars forced open, by the most expert mechanic, during the short time that a man would take in running, or even walking, a mile and a quarter? And suppose a part of the country through which the line of railway passes to be such as we have stated it—barren, desert, and uninhabited —and suppose, also, the railway to be elevated to the height of twelve or fifteen feet, and that an attack were meditated on the carriage, the number qualified to effect its robbery could not, it is likely, escape detection, especially as they must be burdened with ladders, saws, hammers, picklocks, and other implements, for a work that would at least take an hour to accomplish.

But, allow every department of workmanship necessary in the construction of the railway and carriage to be done in the most careful and cautious way, and every part of material required to be of the most substantial and durable quality, and I apprehend no bad consequences either from the efforts of maliciously-disposed persons, from the weight or contents of the carriage, or from the influence of the weather. The line of ground over which it would be suspended, if not in the vicinity of towns or villages, might be adjacent to farm-houses; and, even in the absence of these, the residence of those attending the engines would be within reach of immediate communication. Besides, so long as the railway, with its carriages and engines, answered every purpose for which they were intended, and the *quantum* of velocity stipulated to be gained was confirmed, so long would the eyes and the admiration of the people be directed towards it, and this would operate as one of its most powerful safeguards. I merely state this as a circumstance that had been suggested to me, without placing much confidence in it.

Having now brought before the public a mode of rapid communication calculated, in my opinion, to effect an important change for the better in the affairs of our land; and having, in the preceding pages, stated how such a mode of communication should be established—the expense attending the same—and, so far as they have occurred to me, the purposes to which it may be applied—I beg to submit the whole to the consideration of all who are interested in the welfare and prosperity of the country, and to solicit their attention towards the importance of such a scheme.

FINIS.

E. Macquistan, Printer,
Irvine.

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Feb. 26